PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-263160

(43)Date of publication of application : 13.10.1995

(51)Int.Cl. H05B 41/24
F21S 1/00
H01J 65/04

(21)Application number : 06-079806

(22)Date of filing : 25.03.1994

(71)Applicant : DAIHEN CORP

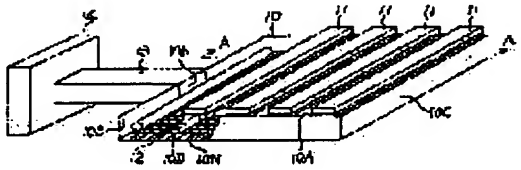
(72)Inventor : YOSHIKI HIROYUKI
SAWAMURA SATOSHI
TSURUTA YOSHINORI
AOYAMA TAKAHIRO

(54) MICROWAVE EXCITED LIGHT SOURCE

(57)Abstract:

PURPOSE: To provide a microwave excited light source suitable for uniform linear or panel illumination.

CONSTITUTION: This is a microwave excited light source which is equipped with a microwave power source 14, a rectangular waveguide tube 13 for introducing the microwaves outputted from the microwave source 11, and a cavity 10 for accommodating the electrodeless lamp 14 generating induction discharge by the microwaves introduced into the rectangular waveguide tube 12 and emitting light, and in which the microwave source 14 and the rectangular waveguide tube 13 and the cavity 10 are electrically connected. This is provided with a U-shaped field generating means 11 consisting of a permanent magnet for forming a magnetic field in the electrodeless lamp 12, and the open side of the field generating means 11 is directed along the electrodeless lamp 12.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] A microwave power source and the rectangular waveguide which introduces the microwave outputted from said microwave power source, In the microwave excitation light source equipment to which the cavity which contained the electrodeless lamp which produces inductive discharge by the microwave introduced into said rectangular waveguide, and emits light was provided, and said microwave power source, rectangular waveguide, and cavity were connected electrically Microwave excitation light source equipment with which the U-shaped field generating means which consists of a permanent magnet which forms a magnetic field was established, and the opening side of said field generating means was turned along with said electrodeless lamp in said electrodeless lamp.
[Claim 2] Said field generating means is microwave excitation light source equipment according to claim 1 which has beyond sufficient magnetomotive force for making a electron cyclotron resonance start.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is light equipment using the electrodeless lamp which produces inductive discharge by microwave and emits light, and relates to the superficially suitable light equipment for the homogeneity exposure by the strong illuminance. Such light equipment is used to carry out decomposition removal of the resist applied on the semi-conductor wafer using ozone and ultraviolet rays for example, in a semi-conductor manufacture process.
[0002]
[Description of the Prior Art] Two or more electrodeless lamps are formed in a cavity, the metal rod for adjustment is further formed in a cavity, and the microwave excitation light source equipment superficially irradiated with a strong illuminance is indicated by JP,2-204902,A.
[0003] Drawing 5 is the outline block diagram showing conventional microwave excitation light source equipment. Two or more straight pipe-like electrodeless lamps 2 are arranged in the cavity 1 of the shape of a flat rectangular parallelepiped at the plane, and the inferior surface of tongue of this cavity is formed at a wire gauze 3, and can take out light now so that it may illustrate.
[0004] The power feed hopper 4 is formed in the above-mentioned cavity 1, and microwave power is supplied from the microwave power source 6 through a waveguide 5. Moreover, the metal rod 7 for adjustment for taking adjustment between the microwave power source 6 and a lamp 2 is formed in the upper part of a cavity, by having consistency by adjusting the insertion length into the cavity of this metal rod, it becomes easy to concentrate the electric field in a cavity on a lamp, and ultraviolet rays are superficially irradiated with a strong illuminance.
[0005]
[Problem(s) to be Solved by the Invention] With the above-mentioned conventional technique, in order to make whenever [Mitsuteru] increase, power was centralized on the lamp by forming the metal rod for adjustment. However, since it was necessary to decide the location and number of this metal rod by trial and error for every configuration of a cavity, they had the problem that a design change was difficult. When it increases beyond a value with a plasma consistency, the cutoff phenomenon of the microwave by the plasma happens and it becomes impossible and for microwave to invade into the plasma, although the luminescence reinforcement of a lamp increases in proportion to the plasma consistency in a lamp. Therefore, there was a problem that the rise of the luminescence reinforcement of the lamp beyond it could not be performed.
[0006]
[Means for Solving the Problem] The rectangular waveguide which introduces the microwave outputted from the microwave power source and the microwave power source in claim 1 of this invention, The cavity which contained the electrodeless lamp which produces inductive discharge by the microwave introduced into rectangular waveguide, and emits light is provided. The U-shaped field generating means which consists of a permanent magnet with which a microwave power source, rectangular waveguide, and a cavity form a magnetic field in an electrodeless lamp for the microwave excitation light source equipment connected electrically is established, and it is characterized by turning the opening side of a field generating means along with an electrodeless lamp.
[0007] Moreover, especially in claim 2, it is characterized by having beyond magnetomotive force for making a electron cyclotron resonance start with a sufficient permanent magnet.
[0008]
[Function] A plasma consistency will be raised, if a field generating means is arranged so that the magnetic field of the direction of a round slice of a lamp may be formed in an electrodeless lamp while exciting the plasma with microwave. By arranging a field generating means so that the direction of the above-mentioned line of magnetic force may become parallel to the direction of a round slice of a lamp, and the travelling direction of microwave especially, and building the field which fills sufficient flux density to start a electron cyclotron resonance (ECR) moreover, an electron obtains energy from microwave, and is accelerated in resonance, consequently the above-mentioned electron ionizes filler gas efficiently, and the plasma state of high density is realized in a lamp. There is no fear of moreover the cutoff phenomenon of the microwave accompanying the rise of a plasma consistency happening by the plasma production by ECR. A single or more figures plasma consistency can be easily raised by starting ECR especially. Therefore, the same luminescence of an illuminance high [but] of incidence microwave power is attained.
[0009]
[Example] Drawing 1 is the outline block diagram showing one example of the microwave excitation light source equipment concerning this invention. The field generating means 11 is formed in a cavity 10, the electrodeless lamp 12 is further contained, and a microwave power source, rectangular waveguide, and a cavity are electrically connected to it, respectively so that microwave power may be supplied to this cavity from the microwave power source 14 through rectangular waveguide 13, so that it may illustrate.
[0010] Power feed hopper 10b is prepared in field 10B of the side which the field generating means 10 is formed in field 10A of a flat rectangular parallelepiped, and is connected with rectangular waveguide 13, and a cavity 10 carries out the termination short circuit of the microwave waveguide by closing this field 10B and field 10C which counters. Furthermore, field 10D is formed at 10-N wire gauze, and light can be taken out from this field 10D. In addition, fields other than the above are closed.
[0011] It is guide wave length lambdag of microwave to the rectangular waveguide 13 side from field 10C which the electrodeless lamp 12 of the shape of two or more straight pipe and 12 -- make carry out the termination short circuit of the microwave waveguide into the above-mentioned cavity 10, and an parallel location, i.e., field 10C. Along with the part of the crest of two or more standing waves located on one fourth of repeat locations, it is arranged, respectively. In addition, as a location which arranges a lamp, also in order to make light emit efficiently, the part of the crest of a standing wave is the best.
[0012] The field generating means 11 is presenting the U shape, it carries out opposite arrangement of the two permanent magnets

11A and 11B of the almost same die length as the die length of an electrodeless lamp 12 so that the magnetization directions may differ, and it constitutes a horseshoe-shaped field generating means with York as shown in drawing 2 using York 11C which makes a magnetic path form among both magnets. That opening side is turned along with the lamp, and this field generating means is arranged where the opening side edge section of a field generating means is moreover embedded at field 10A of a cavity 10. Therefore, as shown in drawing 3 , the line of magnetic force of the direction of a round slice of a lamp arises from a horseshoe-shaped field generating means, if a magnet is arranged so that the magnetic field by this field generating means may be formed in a lamp, plasma-ization of the filler gas of a lamp will be promoted and a plasma consistency will be raised. A field generating means is arranged so that the direction which is the above-mentioned line of magnetic force may become parallel to the direction of a round slice of a lamp, and the travelling direction of microwave especially, and it is set as the flux density with which are satisfied of the conditions of (1) type moreover shown below.

[0013]

Omega=eB/m -- (1)

here -- an electronic cyclotron frequency with omega equal to a microwave frequency, and B -- flux density and m -- mass of electrons and e -- base -- it is a charge. Therefore, it is 2.45GHz about the microwave frequency of the microwave power source 14. Then, it becomes B= 875 gauss.

[0014] As the above-mentioned permanent magnets 11A and 11B, it is Sm Co with strong magnetomotive force. Or Nd-Fe Although used, it is Sm Co strong against heat. It is desirable to use a magnet. Moreover, the magnetic field strength and field distribution to need can be freely adjusted by changing various width methods of York 11C, and extending or narrowing spacing between magnet 11A and 11B.

[0015] An electrodeless lamp 12 has various metals or these halogenides of rare gas, such as Ne and Ar, and a small amount, such as Hg, Cd, and Zn, etc. as matter to enclose, using ultraviolet-rays transparency matter, such as a quartz, as the quality of the material, when changing according to an application, for example, making it into the ultraviolet-rays light source. Furthermore, what is necessary is to take out outside from the stoma which established the end or both ends of a lamp in the side attachment wall of a cavity 10, and just to carry out temperature control so that the part may be maintained at the temperature corresponding to the optimal vapor pressure of an enclosure metal in order to optimize the luminescence reinforcement of a lamp. For example, when carrying out small amount enclosure of the Hg and using wavelength (185nm and 254nm) of ultraviolet radiation, it cools with liquids, such as water, so that it may keep at 40-70 degrees C. In this case, although it is not illustrating in order for microwave to prevent revealing outside, there is wrap need by the metal shielding box about the lamp section exposed outside.

[0016] Drawing 4 is drawing showing the relation of the luminescence reinforcement and flux density by this invention in Ne gas-charging straight pipe lamp. Incidence microwave power is fixed 100W, and measures the light with a wavelength of 633nm. The light-receiving area of a sensor is phi 18, and is as a result of [in a place with a distance / from a lamp / of about 40mm] measurement. The increment in luminescence reinforcement is seen by 900 gauss or more. Furthermore, as compared with the value in case a 1400 gauss optical output does not have a magnetic field, the about 1.4 times as many increment as this was checked.

[0017] Although a U character mold or a V character mold may be used although the field generating means 11 which presented the U shape was made horseshoe-shaped, and carried out with York, a permanent magnet may constitute all from this example. Furthermore, although the opening side edge section of a permanent magnet is arranged in the condition of having been embedded at field 10A of a cavity 10, this edge may be made to contact the top face of a cavity, and you may make it isolated from the top face of a cavity.

[0018] Moreover, as an electrodeless lamp 12, although five straight pipe lamps are arranged in a cavity 10, they may be more than it or the following. Moreover, a straight pipe lamp may be used as a U character-like lamp and a spherical lamp, and a large area can be irradiated with the lamp formed still more flatly.

[0019] Furthermore, since microwave is aslant spread by repeating reflection by the side attachment wall inside a cavity, they do not need to make it arrange in above-mentioned field 10C and parallel, although the field generating means 11 and the electrodeless lamp 12 are arranging microwave waveguide in a location parallel to field 10C which carries out a termination short circuit.

[0020] Moreover, the injection effectiveness of the microwave power to a cavity can be raised by setting up the dimension of a cavity 10 so that it may resonate on the frequency of a microwave power source.

[0021] Furthermore, microwave may supply power continuously and may be made to supply it in the shape of a pulse (pulse discharge).

[0022]

[Effect of the Invention] As mentioned above, since two or more lamps can be turned on to homogeneity more efficiently by being raised more than the plasma consistency in the case of exciting the plasma with microwave according to invention of claim 1, without carrying out a design change corresponding to the specification of equipment each, a large area can be irradiated with a high illuminance. Moreover, by using a permanent magnet, equipment can be miniaturized, moreover the bad influence of the field to other fields other than a lamp can be stopped, and the locked-in effect of the plasma by the magnetic field works effectively.

[0023] Moreover, since implementation ****** can do the plasma state of the high density which raised the single or more figures plasma consistency easily especially according to invention of claim 2, incidence microwave power can make light emit with the same high illuminance but.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram showing one example of the microwave excitation light source equipment concerning this invention.
[Drawing 2] It is the outline block diagram showing the field generating means of this invention.
[Drawing 3] It is the sectional view which met the A-A line of drawing 1 .
[Drawing 4] It is drawing showing the relation of the luminescence reinforcement and flux density by this invention in Ne gas-charging straight pipe lamp.
[Drawing 5] It is the outline block diagram showing conventional microwave excitation light source equipment.
[Description of Notations]
10 Cavity
11 Field Generating Means
12 Electrodeless Lamp
13 Rectangular Waveguide
14 Microwave Power Source

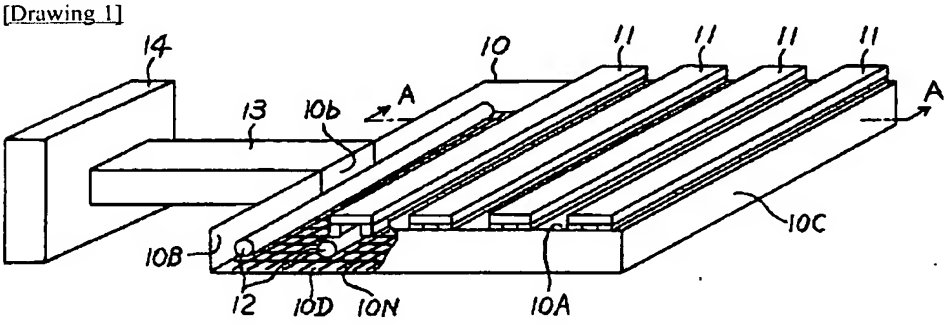
[Translation done.]

* NOTICES *

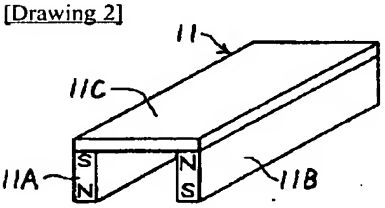
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

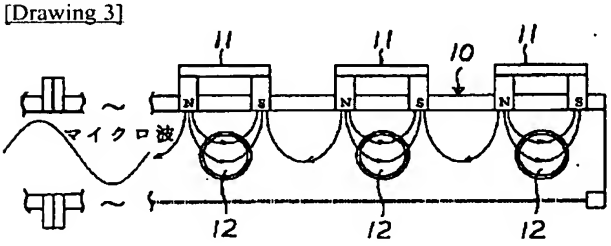
[Drawing 1]



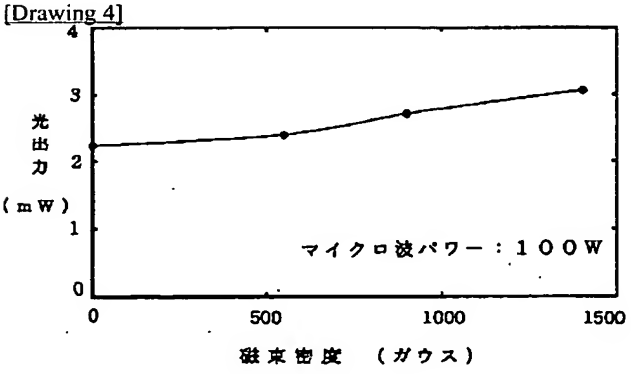
[Drawing 2]



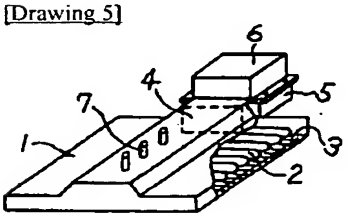
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 07263160
PUBLICATION DATE : 13-10-95

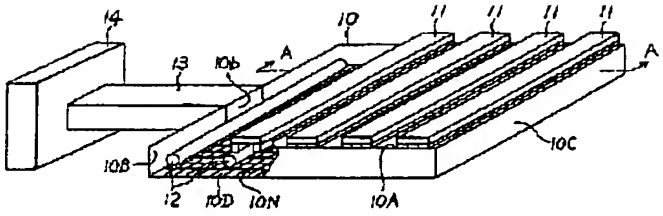
APPLICATION DATE : 25-03-94
APPLICATION NUMBER : 06079806

APPLICANT : DAIHEN CORP;

INVENTOR : AOYAMA TAKAHIRO;

INT.CL. : H05B 41/24 F21S 1/00 H01J 65/04

TITLE : MICROWAVE EXCITED LIGHT SOURCE



ABSTRACT : PURPOSE: To provide a microwave excited light source suitable for uniform linear or panel illumination.

CONSTITUTION: This is a microwave excited light source which is equipped with a microwave power source 14, a rectangular waveguide tube 13 for introducing the microwaves outputted from the microwave source 11, and a cavity 10 for accommodating the electrodeless lamp 14 generating induction discharge by the microwaves introduced into the rectangular waveguide tube 12 and emitting light, and in which the microwave source 14 and the rectangular waveguide tube 13 and the cavity 10 are electrically connected. This is provided with a U-shaped field generating means 11 consisting of a permanent magnet for forming a magnetic field in the electrodeless lamp 12, and the open side of the field generating means 11 is directed along the electrodeless lamp 12.

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報（Ａ）**　(11)特許出願公開番号

特開平7－263160

(43)公開日　平成７年(1995)10月13日

(51)Int.Cl.⁶	識別記号	庁内整理番号	Ｆ１	技術表示箇所
Ｈ０５Ｂ 41/24		Ｎ		
Ｆ２１Ｓ 1/00		Ｐ		
Ｈ０１Ｊ 65/04		Ｂ		

審査請求　未請求　請求項の数２　ＦＤ　（全 4 頁）

(21)出願番号　特願平6－79806

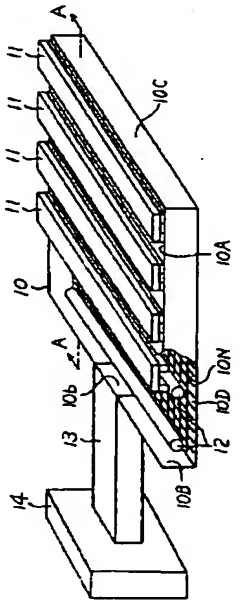
(22)出願日　平成６年(1994)３月25日

(71)出願人　000000262
株式会社ダイヘン
大阪府大阪市淀川区田川２丁目１番11号
(72)発明者　吉木　宏之
大阪市淀川区田川２丁目１番11号　株式会社ダイヘン内
(72)発明者　澤村　智
大阪市淀川区田川２丁目１番11号　株式会社ダイヘン内
(72)発明者　鍋田　義範
大阪市淀川区田川２丁目１番11号　株式会社ダイヘン内
(74)代理人　弁理士　中井　宏

最終頁に続く

(54)【発明の名称】　マイクロ波励起光源装置

(57)【要約】　（修正有）
【目的】　平面的に強い照度による均一照射に好適なマイクロ波励起光源装置を得る。
【構成】　マイクロ波電源１４と、マイクロ波電源１４から出力されたマイクロ波を導入する矩形導波管１３と、矩形導波管１３に導入されたマイクロ波により誘導放電を生じ発光する無電極ランプ１２を収納した空胴１０とを具備し、マイクロ波電源１４と矩形導波管１３と空胴１０とが電気的に接続されたマイクロ波励起光源装置において、無電極ランプ１２内に磁場を形成する永久磁石からなるコ字状の磁界発生手段１１を設け、磁界発生手段１１の開口側が無電極ランプ１２に沿って向けられたことを特徴とする。



1

【特許請求の範囲】

【請求項1】　マイクロ波電源と、前記マイクロ波電源から出力されたマイクロ波を導入する矩形導波管と、前記矩形導波管に導入されたマイクロ波により誘導放電を生じ発光する無電極ランプを収納した空胴とを具備し、前記マイクロ波電源と矩形導波管と空胴とが電気的に接続されたマイクロ波励起光源装置において、

前記無電極ランプ内に磁場を形成する永久磁石からなるコ字状の磁界発生手段を設け、前記磁界発生手段の開口側が前記無電極ランプに沿って向けられたマイクロ波励起光源装置。

【請求項2】　前記磁界発生手段は、電子サイクロトロン共鳴を起こさせるに充分な起磁力以上を有する請求項1に記載のマイクロ波励起光源装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、マイクロ波により誘導放電を生じ発光する無電極ランプを用いた光源装置で、平面的に強い照度による均一照射に好適な光源装置に関するものである。このような光源装置は、例えば半導体製造プロセスで半導体ウエハー上に塗布されたレジストをオゾンと紫外線を用いて分解除去するのに使われる。

【0002】

【従来の技術】複数個の無電極ランプを空胴内に設け、さらに空胴に整合用金属棒を設けて、平面的に強い照度で照射を行うマイクロ波励起光源装置が、特開平2－204902号公報に開示されている。

【0003】図5は従来のマイクロ波励起光源装置を示す概略構成図である。図示するように、偏平な直方体状の空胴1内に直管状の無電極ランプ2を複数個平面状に配置しており、この空胴の下面は金網3で形成され、光が取り出せるようになっている。

【0004】上記空胴1には電力供給口4を設け、導波管5を介してマイクロ波電源6からマイクロ波電力が供給される。また、空胴の上部には、マイクロ波電源6とランプ2との間の整合をとるための整合用金属棒7が設けられており、この金属棒の空胴内への挿入長を調整して整合を行うことによって、空胴内の電界がランプに集中しやすくなり、紫外線が平面的に強い照度で照射される。

【0005】

【発明が解決しようとする課題】上記従来技術では、光照度を増加させるために、整合用金属棒を設けることによって、ランプに電力を集中させていた。しかし、この金属棒の位置や本数は、空胴の形状ごとに試行錯誤的に決める必要があるために、設計変更が困難であるという問題があった。しかも、ランプの発光強度はランプ内のプラズマ密度に比例して増加するが、プラズマ密度がある値以上に増加すると、プラズマによるマイクロ波の遮断現象が起こり、マイクロ波がプラズマ中に侵入できなくなる。したがって、それ以上のランプの発光強度の上昇ができないという問題があった。

2

【0006】

【課題を解決するための手段】本発明の請求項1においては、マイクロ波電源と、マイクロ波電源から出力されたマイクロ波を導入する矩形導波管と、矩形導波管に導入されたマイクロ波により誘導放電を生じ発光する無電極ランプを収納した空胴とを具備し、マイクロ波電源と矩形導波管と空胴とが電気的に接続されたマイクロ波励起光源装置を対象とし、無電極ランプ内に磁場を形成する永久磁石からなるコ字状の磁界発生手段を設け、磁界発生手段の開口側が無電極ランプに沿って向けられたことを特徴とする。

【0007】また請求項2においては、特に、永久磁石が電子サイクロトロン共鳴を起こさせるに充分な起磁力以上を有することを特徴とする。

【0008】

【作用】マイクロ波でプラズマを励起すると共に、無電極ランプ内にランプの輪切り方向の磁場が形成されるように磁界発生手段を配置すると、プラズマ密度が高められる。特に、上記の磁力線の方向がランプの輪切り方向かつマイクロ波の進行方向と平行となるように磁界発生手段を配置し、しかも電子サイクロトロン共鳴（ＥＣＲ）を起こすに充分な磁束密度を満たす領域をつくることによって、電子はマイクロ波からエネルギーを得て共鳴的に加速され、その結果、上記電子は封入ガスを効率良く電離し、ランプ内に高密度のプラズマ状態を実現する。その上、ＥＣＲによるプラズマ生成では、プラズマ密度の上昇にともなうマイクロ波の遮断現象が起こる心配はない。特に、ＥＣＲを起こすことによって、プラズマ密度を容易に1桁以上高めることができる。したがって、入射マイクロ波パワーが同じでも高い照度の発光が可能となる。

【0009】

【実施例】図1は本発明に係るマイクロ波励起光源装置の一実施例を示す概略構成図である。図示するように、空胴10には、磁界発生手段11が設けられ、さらに無電極ランプ12が収納されており、この空胴に矩形導波管13を介してマイクロ波電源14からマイクロ波電力が供給されるように、マイクロ波電源、矩形導波管及び空胴がそれぞれ電気的に接続されている。

【0010】空胴10は、偏平な直方体の面10Ａに磁界発生手段10が設けられ、また矩形導波管13と接続される側の面10Ｂに電力供給口10ｂが設けられ、この面10Ｂと対向する面10Ｃを閉鎖することによって、マイクロ波導波路を終端短絡させるようになっている。さらに面10Ｄが10Ｎ金網で形成され、この面10Ｄから光が取り出せる。なお、上記以外の面は閉鎖されている。

【0011】上記空胴10内には、複数本の直管状の無

3

電極ランプ１２，１２…がマイクロ波導波路を終端短絡させる面１０Ｃと平行な位置、すなわち面１０Ｃから矩形導波管１３側へ、マイクロ波の管内波長λｇの１／４の繰り返し位置に立つ複数個の定在波の山の部分に沿ってそれぞれ配置される。なお、ランプを配置する位置としては、効率よく発光させるためにも定在波の山の部分が最もよい。

【００１２】磁界発生手段１１は、コ字状を呈しており、無電極ランプ１２の長さとほぼ同じ長さの２つの永久磁石１１Ａ，１１Ｂを着磁方向が異なるように対向配置させ、両磁石の間に磁路を形成させるヨーク１１Ｃを用いて、図２に示すようなヨーク付コ字型磁界発生手段を構成する。この磁界発生手段は、その開口側がランプに沿って向けられており、しかも磁界発生手段の開口側端部が空胴１０の面１０Ａに埋め込まれた状態で配設されている。したがって、図３に示すように、コ字型磁界発生手段からランプの輪切り方向の磁力線が生じ、この磁界発生手段による磁場がランプ内に形成されるように磁石を配置すると、ランプの封入ガスのプラズマ化を促進して、プラズマ密度が高められる。特に、上記の磁力線の方向がランプの輪切り方向かつマイクロ波の進行方向と平行となるように磁界発生手段を配置し、しかも次に示す（１）式の条件を満足する磁束密度に設定する。

【００１３】

$$\omega = eB/m \quad \cdots (1)$$

ここで、ωはマイクロ波周波数に等しい電子サイクロトロン周波数、Ｂは磁束密度、ｍは電子の質量、ｅは素電荷である。したがって、マイクロ波電源１４のマイクロ波周波数を例えば２．４５ＧＨｚとすれば、Ｂ＝８７５ガウスになる。

【００１４】上記永久磁石１１Ａ，１１Ｂとしては、起磁力の強いＳｍ Ｃｏ またはＮｄ －Ｆｅ が用いられるが、熱に強いＳｍ Ｃｏ 磁石を使用するのが好ましい。また、ヨーク１１Ｃの幅寸法を種々変化させて、磁石１１Ａ，１１Ｂ間の間隔を広げたり狭めたりすることによって、必要とする磁界の強さ及び磁界分布を自由に調整することができる。

【００１５】無電極ランプ１２は、用途に応じて変わり、例えば紫外線光源とする場合、その材質として石英などの紫外線透過物質を用い、また封入する物質としてＮｅ，Ａｒなどの希ガスと小量のＨｇ，Ｃｄ，Ｚｎなどの各種金属またはこれらのハロゲン化物などがある。さらに、ランプの発光強度を最適化するために、ランプの一端または両端を空胴１０の側壁に設けた小孔より外部に出し、その部分を封入金属の最適蒸気圧に対応する温度に保つように温度制御すれば良い。例えばＨｇを小量封入し、１８５ｎｍ及び２５４ｎｍの波長の紫外光を利用する場合は、４０～７０℃に保つように水等の液体で冷却する。この場合、マイクロ波が外に漏洩するのを防ぐために、図示していないが、外部に露出したランプ部を金

4

属しゃへい箱で覆う必要がある。

【００１６】図４はＮｅガス封入直管ランプでの本発明による発光強度と磁束密度との関係を示す図である。入射マイクロ波パワーは１００Ｗ一定で、６３３ｎｍの波長の可視光を測定したものである。センサーの受光面積はφ１８で、ランプからの距離約４０ｍｍの所での測定結果である。９００ガウス以上で発光強度の増加が見られる。さらに、１４００ガウスでの光出力は、磁場の無い場合の値と比較して約１．４倍の増加が確認された。

【００１７】本実施例では、コ字状を呈した磁界発生手段１１をコ字型としたが、Ｕ字型またはＶ字型でも良く、またヨーク付としたが、全て永久磁石により構成しても良い。さらに、永久磁石の開口側端部が、空胴１０の面１０Ａに埋め込まれた状態で配設されているが、この端部を空胴の上面に当接させても良く、また空胴の上面から離隔させても良い。

【００１８】また、無電極ランプ１２として、５個の直管ランプを空胴１０内に配置しているが、それ以上でも以下でも良い。また、直管ランプを、Ｕ字状ランプ、球状ランプにしても良く、さらに偏平に形成したランプにより広い面積を照射できる。

【００１９】さらに、磁界発生手段１１及び無電極ランプ１２は、マイクロ波導波路を終端短絡させる面１０Ｃと平行な位置に配設しているが、マイクロ波は、空胴内部の側壁で反射を繰り返すことにより斜めに伝搬するので、上記面１０Ｃと平行に配設させる必要はない。

【００２０】また、空胴１０の寸法をマイクロ波電源の周波数で共鳴するように設定することによって、空胴へのマイクロ波電力の投入効率を高めることができる。

【００２１】さらに、マイクロ波は、連続的にパワーを投入しても良いし、パルス状に投入（パルス放電）させても良い。

【００２２】

【発明の効果】以上のように、請求項１の発明によれば、装置個々の仕様に対応して設計変更させることなく、マイクロ波でプラズマを励起する場合のプラズマ密度以上に高められることによって、複数個のランプをより効率良く、しかも均一に点灯できるので、広い面積を高い照度で照射できる。また、永久磁石を用いることにより装置を小型化でき、しかもランプ以外の他の領域への磁界の悪影響を抑えることができ、磁場によるプラズマの閉じ込め効果が有効に働く。

【００２３】また請求項２の発明によれば、特に、プラズマ密度を容易に１桁以上高めた高密度のプラズマ状態を実現することができるので、入射マイクロ波パワーが同じでも高い照度で発光させることができる。

【図面の簡単な説明】

【図１】本発明に係るマイクロ波励起光源装置の一実施例を示す概略構成図である。

【図２】本発明の磁界発生手段を示す概略構成図であ

る。

【図3】図1のA－A線に沿った断面図である。

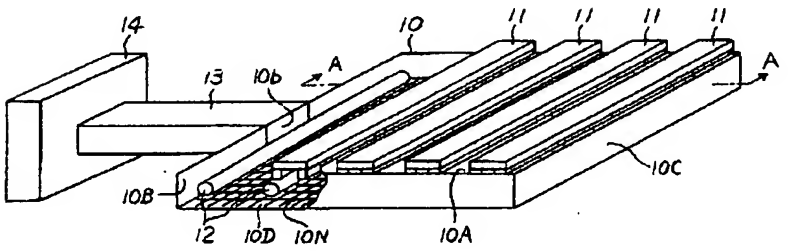
【図4】Neガス封入直管ランプでの本発明による発光強度と磁束密度との関係を示す図である。

【図5】従来のマイクロ波励起光源装置を示す概略構成図である。

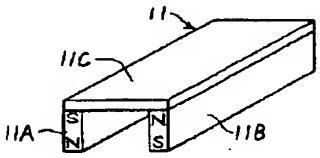
【符号の説明】

10　空胴
11　磁界発生手段
12　無電極ランプ
13　矩形導波管
14　マイクロ波電源

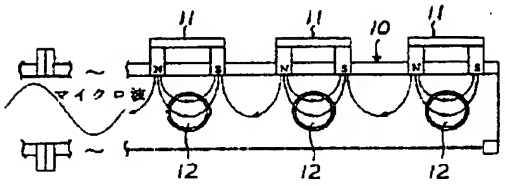
【図1】



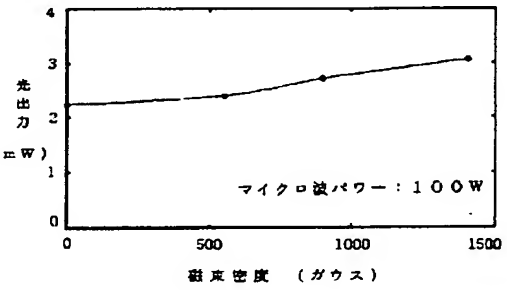
【図2】



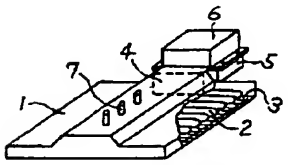
【図3】



【図4】



【図5】



フロントページの続き

(72)発明者　青山　隆浩
大阪市淀川区田川2丁目1番11号　株式会
社ダイヘン内